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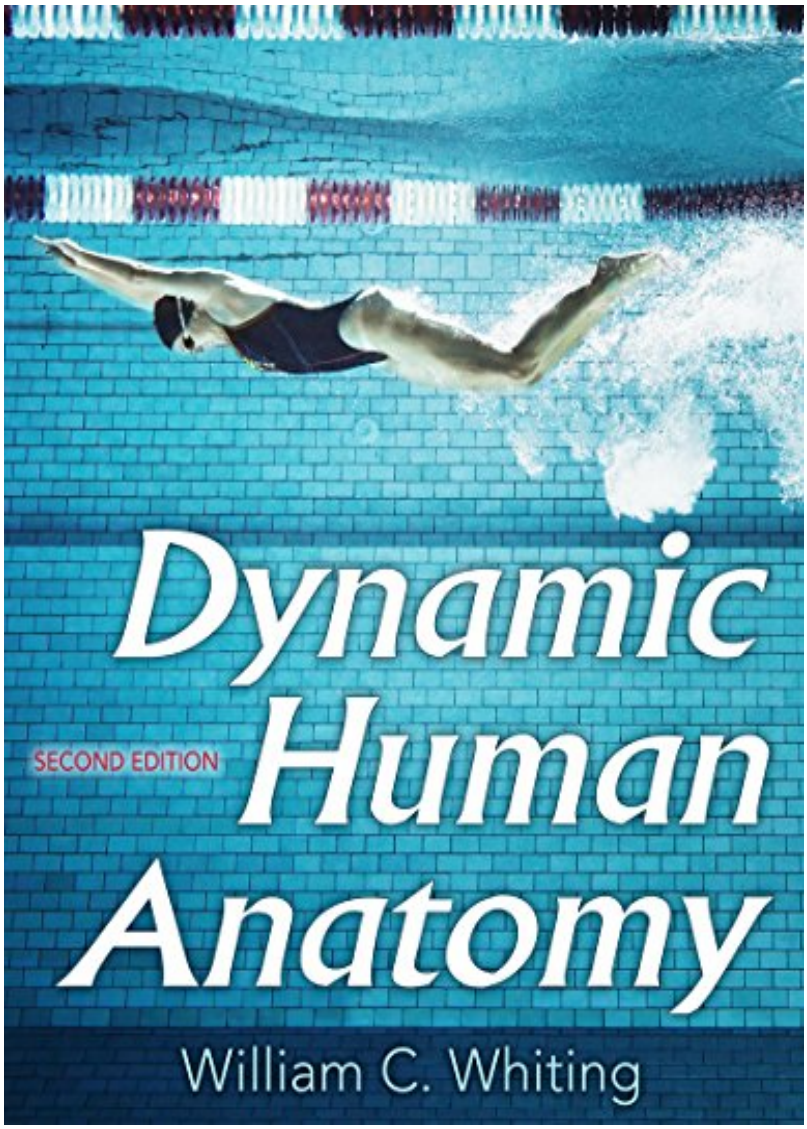

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Dynamic Human Anatomy

SECOND EDITION

William C. Whiting

Dynamic Human Anatomy

SECOND EDITION

William C. Whiting, PhD

California State University, Northridge

HUMAN KINETICS

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E7051

With everlasting love to my wife, Marji; sons, Trevor and Tad;
and daughter, Emmi, for giving special meaning to my life.

In loving memory of two colleagues and good friends,
Jennifer Romack and Shane Frehlich, who left us too soon.

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Preface

No earthly creation is as intricate, versatile, or mysterious as the human body. Our bodies perform countless functions that ensure our existence. Of all the body's functions, movement is arguably the most essential, for without movement, the human body could not survive. With movement, the body flourishes. At one end of the movement spectrum, the capacity for purposeful movement allows us to maintain fundamental physiological processes; at the other end, it allows us to pursue the limits of athletic and artistic expression.

For those involved in the many areas of human health and performance, knowledge of the body's structure and function is essential. Students in these areas undoubtedly have taken introductory courses in human anatomy. All too often, however, these courses (which attempt to cover all of the body's systems in a single academic term) provide students with the basics of structural anatomy but offer limited exposure to the elegance and complexity of the body's functional movement anatomy.

From my experience teaching human anatomy, kinesiology, and biomechanics over the past three decades, I can attest to the unfortunate fact that some students emerge from their introductory anatomy experience with limited competency in applying their anatomical knowledge to human movement problems. These students have learned what I refer to (not too euphemistically, and only somewhat kiddingly) as "dead anatomy."

The purpose of this book is to bring anatomy to life by exploring the marvelous potential of the human body to express itself through movement and to provide students with the information and skills they need to appreciate and assess dynamic human anatomy.

Organization

This book, the successor edition to *Dynatomy: Dynamic Human Anatomy* (Whiting & Rugg, 2006), has been developed primarily for students who already have taken, or currently are taking, an introductory course in human anatomy and who need a more detailed exposure to concepts of human *movement* anatomy. These students include those in the fields of exercise science and human movement studies, kinesiology, biomechanics, physical education, coaching, athletic training, ergonomics, and the health sciences (e.g., medicine, physical therapy).

Given the amount of material presented and memorized in introductory anatomy courses, it is neither unusual nor unexpected that students forget many of the details. Thus, part I (Anatomical Foundations) provides a concise review of relevant anatomical information and neuromechanical concepts. Part I begins in chapter 1 (Introduction to Human Anatomy and Movement) with an introduction to the dynamics of human movement and essentials of anatomical structure. The chapter presents a brief overview of motor behavior, including lifespan motor development, motor control, and motor learning, and it establishes a contextual framework for later discussion of specific movements and populations.

Chapter 2 (Osteology and the Skeletal System) describes the microstructure and macroscopic morphology of bone and the organization of the skeletal system. It also identifies specific bones and bony landmarks.

Part I continues in chapter 3 (Joint Anatomy and Function) with a discussion of joint structure, function, and motion, along with a description of major joints of the extremities and spine. Chapter 4 (Skeletal Muscle) begins with a discussion of the structure and function of skeletal muscle and the basic physiology and mechanics of muscle action. The chapter continues with exploration of muscle actions; voluntary, reflex, and stereotypical movements; nervous system control of muscle action; and factors (e.g., muscle length and velocity, fiber

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type, and muscle architecture) that affect muscle force production. It concludes with a presentation of the primary muscles responsible for the production and control of human movement.

With the requisite anatomical and neuromechanical foundations in place, part II (Biomechanics and Movement Control) provides the essentials of a dynamic approach to movement. This part begins in chapter 5 (Biomechanics) with a review of mechanical concepts essential to an understanding of human movement. Chapter 6 (Muscular Control of Movement and Movement Assessment) explains the muscle control formula, a set of simple steps used to identify the muscles and types of muscle actions responsible for producing or controlling human movements. Numerous examples, using simple movement patterns, demonstrate the utility of the formula. Mastery of the muscle control formula provides a valuable tool for independent assessment of muscle action across a broad spectrum of human movements. Chapter 6 concludes with consideration of several important topics relevant to movement assessment. These include single-joint versus multijoint movements, coordination, movement efficiency, and assessment of movement.

Part III (Fundamentals of Movements) begins in chapter 7 (Posture and Balance) with a discussion of the types and functions of posture and balance, mechanisms of postural control, postural alterations and perturbations, developmental considerations, life-span aspects of balance, and postural dysfunction. Chapter 8 (Gait) explores various aspects of walking and running gait. Part III concludes with chapter 9 (Basic Movement Patterns), which examines the fundamental movement patterns of jumping, kicking, lifting, throwing, and striking.

With the anatomical, biomechanical, and basic movement pattern foundations in place, part IV (Movement Applications) discusses movement-related aspects of strength and conditioning applications (chapter 10), sport and dance applications (chapter 11), clinical applications (chapter 12), and ergonomics applications (chapter 13).

One of the primary goals of this book has been to include concepts not found in many traditional anatomy texts, concepts that emphasize function and application. An understanding of the material covered will enhance your preparation for work in the many areas of human movement. To assist you is a comprehensive glossary that defines hundreds of important terms and concepts. Terms boldfaced in the text can be found in the glossary. Each chapter also includes objectives and critical thinking questions to guide and challenge students, as well as suggested readings for further study.

Updates to the Second Edition

The second edition has been updated to include recent research and citations. Additional sidebars have been included to present applications of concepts and movement-related research in biomechanics. Three new chapters have been added to expand on applications in the areas of strength and conditioning (chapter 10), clinical issues (chapter 12), and ergonomics (chapter 13). In addition, chapter 11 (Sport and Dance Applications) has been expanded to cover movement mechanics in baseball and softball, basketball, American football, golf, soccer, tennis, and volleyball.

Student Resources

Students have access to a web study guide that provides several learning aids:

- Summary of articulations for the spine and upper and lower extremities
- Tables that provide the origin, insertion, action, and innervation for all major muscle groups
- Interactive practice problems that allow students to apply the muscle control formula discussed in chapter 6
- Critical thinking questions

The web study guide is available at www.HumanKinetics.com/DynamicHumanAnatomy.

Instructor Resources

New to this edition is a full array of instructor resources:

- **Presentation package:** More than 270 slides present the key concepts from the chapters, including select figures and tables. These slides can be updated to fit unique lecture and classroom needs.
- **Image bank:** The image bank includes most of the figures and tables from the text. These images can be used to supplement PowerPoint slides, lectures, student handouts, and so on.
- **Instructor guide:** The instructor guide provides an introduction on how to use the ancillaries, suggestions for student activities, a sample syllabus, and chapter-specific files that include summaries and lecture outlines. It also includes the answers to the critical thinking questions in the web study guide.
- **Test package:** The test package includes 330 questions that instructors can use to build quizzes to test student understanding.

The instructor ancillaries are available at www.HumanKinetics.com/DynamicHumanAnatomy.

Final Thoughts

Please keep in mind that the material in this text is only a beginning. Consideration of any one of the many topics presented could be expanded to fill a chapter, or even a book, of its own. I make no pretense of having exhaustively covered any of the topics, but rather have sought to present a concise introduction to many of the fascinating areas of human movement.

This book will have served its purpose well if you emerge with an appreciation for human movement that is more wondrous and less mysterious than when your journey began. In the words of British author Laurence Sterne, "So much of motion, is so much of life, and so much of joy" (1980, p. 354).

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Acknowledgments

Although only one name appears on its cover, this book could not have been completed without the contributions of many people. I extend my thanks to the many friends and colleagues who have contributed to its completion. I am especially grateful to Stuart Rugg, my coauthor on the first edition of this book. His valuable contributions helped lay the foundation for this second edition.

Special thanks to Bob Gregor and Ron Zernicke for sharing their knowledge and enthusiasm for biomechanics and helping me develop my love of teaching. Thanks also to Judi Smith for her pioneering work in establishing the human anatomy program in the then–Department of Kinesiology at UCLA that helped provide me with my foundation in anatomy and my belief in the remarkable power of human movement.

My thanks to the staff at Human Kinetics, especially Josh Stone and Amanda Ewing, for their outstanding assistance, patience, support, and belief in this project.

And finally, and most importantly, I thank my family for their unwavering support and love, during the course of this project and always!

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PART

Anatomical Foundations

The four chapters of part I present a concise review of human anatomy and a conceptual framework for our discussion of human movement. Chapter 1 (Introduction to Human Anatomy and Movement) introduces anatomical and movement concepts that form the foundation for understanding details presented in subsequent chapters. Chapter 2 (Osteology and the Skeletal System) reviews the organization of the skeletal system and details of bone structure and function. Using the information presented in chapter 2, our discussion continues in chapter 3 (Joint Anatomy and Function) with examination of the articular system and joint motion, including review of the major joints involved in human movement. Chapter 4 (Skeletal Muscle) explores the structure and function of skeletal muscle, the tissue that provides the force needed to produce and control our movements. In this chapter, we also examine factors that affect muscle force production. Chapter 4 concludes part I with a presentation of the muscles of movement and a summary of the specific muscles responsible for movement control.

The information presented in part I is essential to our understanding of dynamic human anatomy. These chapters set the stage for our application of dynamic human anatomy to a wide variety of human movements.

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1

Introduction to Human Anatomy and Movement

Objectives

After studying this chapter, you will be able to do the following:

- Define the terms *anatomy* and *physiology* and describe the relationship between these two areas of study
- Explain the importance of movement in our daily lives
- Understand how movement changes across the life span
- Describe the importance of understanding motor behavior and its subareas of motor control, motor learning, and motor development
- Explain movement considerations in younger and older populations
- Describe the importance of differences in movement ability among individuals
- Explain the anatomical concepts of complexity, variability, individuality, adaptability, connectivity, and asymmetry
- Describe the levels of structural organization and primary tissue types
- Explain the structure and function of muscle and connective tissues
- Define and explain anatomical terms describing body regions, body positions, movement planes, axes of rotation, joint positions, and movements
- Appreciate the multidisciplinary perspective necessary for understanding human movement

In this introductory chapter, we establish the conceptual framework for understanding the details of human anatomy and movement in the chapters that follow. In building this framework, we take a life-span approach and focus on general anatomical terminology and concepts and an overview of human structure. We emphasize the elements of anatomy (e.g., bones and muscles) directly related to human movement.

Introduction to Human Anatomy

Anatomy, simply defined, is the study of the structure of organisms. The term derives from the Greek *anatome*, which means "to dissect" or "to cut." The organism considered here is the human organism. Historically, dissection has been a primary means of discovery about the structure of the human organism, and it remains a useful educational tool in training professionals in the health sciences (e.g., medicine, physical therapy). However, in recent decades, technological advances of many kinds (e.g., MRI, CAT scans) have allowed us to better understand the body's structure without cutting it open.

Anatomy is an expansive science that encompasses many branches, or subdivisions. Some of these subdivisions are described in table 1.1. In establishing our anatomical foundation for study of human movement, we focus on gross (macroscopic) anatomy, systemic anatomy (especially the skeletal, muscular, and nervous systems), regional anatomy as it relates to specific movement patterns, and, most importantly, functional anatomy.

Although anatomy is our focus, the related area of **physiology**, which deals with the *functions* of the body parts and systems, deserves mention. Anatomy and physiology are closely related, and study of one without consideration of the other makes little sense. We begin by presenting, in elementary terms, the origin, development, and structure of the body's components and then show how the parts are both structurally and functionally interconnected.

We begin with an overview of human movement, followed by an introduction to concepts of functional anatomy. These anatomical concepts form a necessary foundation for your understanding of dynamic human anatomy.

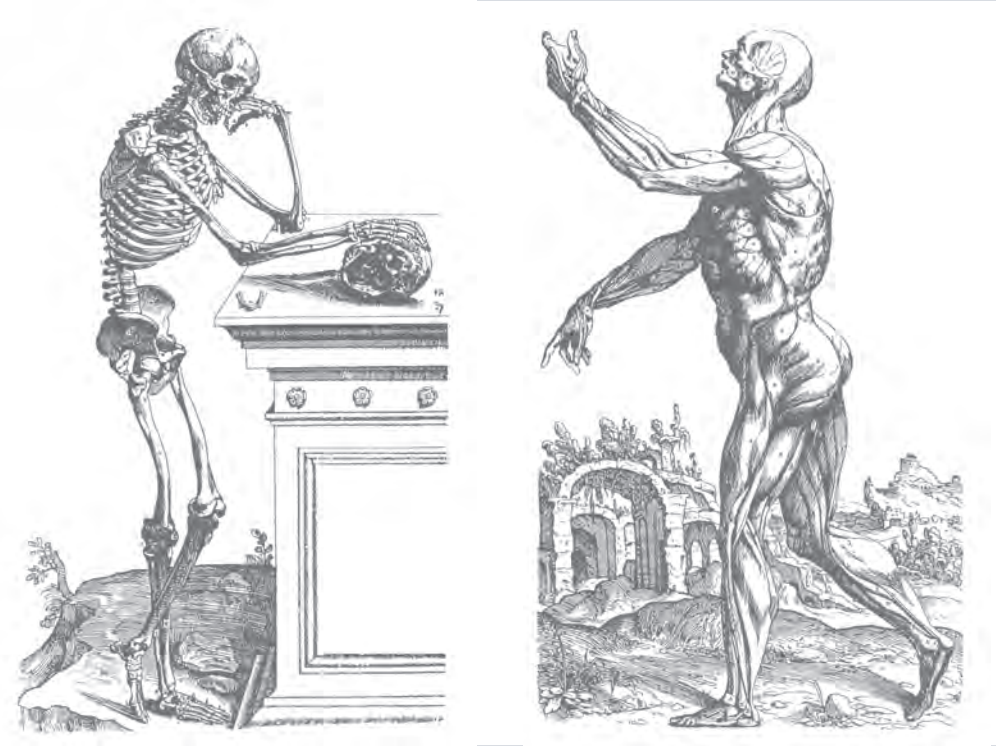
TABLE 1.1 Subdivisions of Anatomy

Anatomy subdivision	Description
Gross (macroscopic) anatomy	Study of structures without the aid of a microscope
Microscopic anatomy	Study of structures using microscopic techniques
Systemic anatomy	Study of specific body systems (e.g., skeletal, muscular, nervous, respiratory, cardiovascular)
Regional anatomy	Study of specific body regions (e.g., head, extremities)
Functional anatomy	Study of how body systems (e.g., skeletal, muscular, nervous) work cooperatively to perform various functions
Surface anatomy	Study of landmarks on the surface of the body
Developmental anatomy	Study of structural development across the life span, from fertilization to death
Embryology	Study of development from fertilization through the 8th week in utero
Histology	Microscopic study of tissue structure
Cytology	Microscopic study of cell structure

Applying the Concept

Vesalius

Some of the most admired anatomical treasures of the Renaissance were drawn by Andreas Vesalius (1514-1564). His master work, *De Humani Corporis Fabrica* (1543), stands as one of the great volumes in the history of modern science. In this work, Vesalius blended text with picture into a truly integrated presentation of his understanding of human anatomy.



THE ANATOMICAL legacy of Vesalius.

Introduction to Human Movement

Movement is a fundamental behavior essential for life itself. Life processes such as blood circulation, respiration, and muscle contraction require motion, as do activities such as walking, bending, and lifting. The human organism seeks, consciously or not, to move. Children, in particular, provide clear evidence of the inherent nature of humans to move. They never seem to stop. Even as we age and slow down, movement remains an essential part of our lives. As noted by French scientist and philosopher Blaise Pascal (1623-1662), "Our nature consists in motion; complete rest is death" (Pascal & Krailsheimer, 1995, p. 211).

At one end of the spectrum, the capacity for purposeful movement supports basic physiological processes; at the other end, movement allows us to explore the limits of athletic and artistic expression. Limited movement, such as when a person is bedridden or elects a sedentary lifestyle, can contribute to adverse health conditions such as cardiovascular disease, diabetes, and cancer. Thus our ability to move, or the choice to limit movement, may contribute, either directly or indirectly, to our susceptibility to disease and injury.

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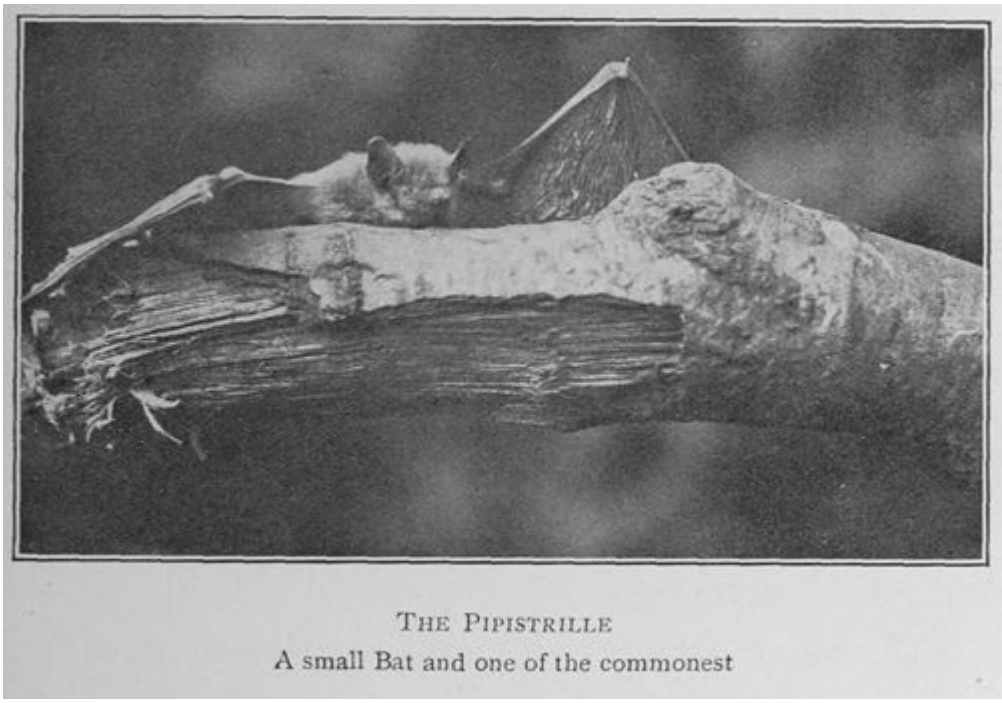
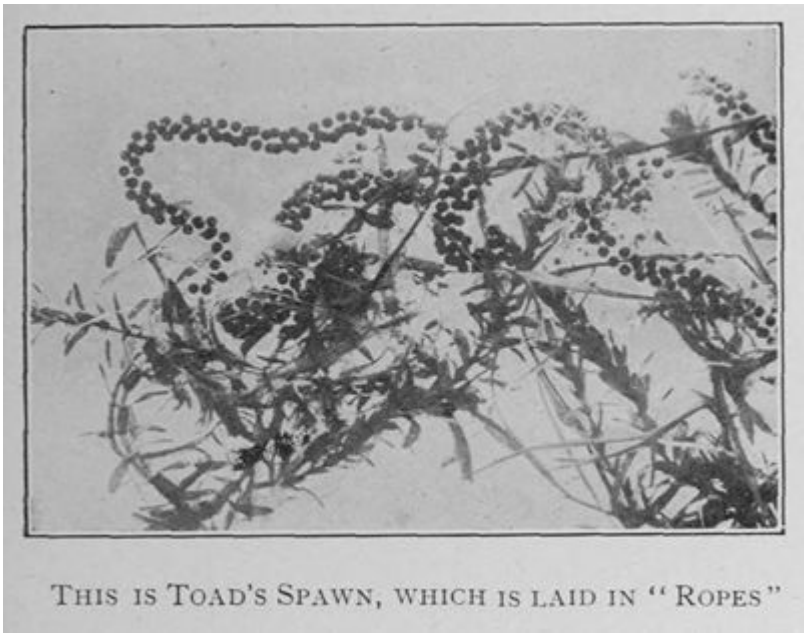


THE PIPISTRILLE
A small Bat and one of the commonest

THE PIPISTRILLE
A small Bat and one of the commonest

SOMETHING ABOUT TADPOLES

(FEBRUARY)



THIS IS TOAD'S SPAWN, WHICH IS LAID IN "ROPES"

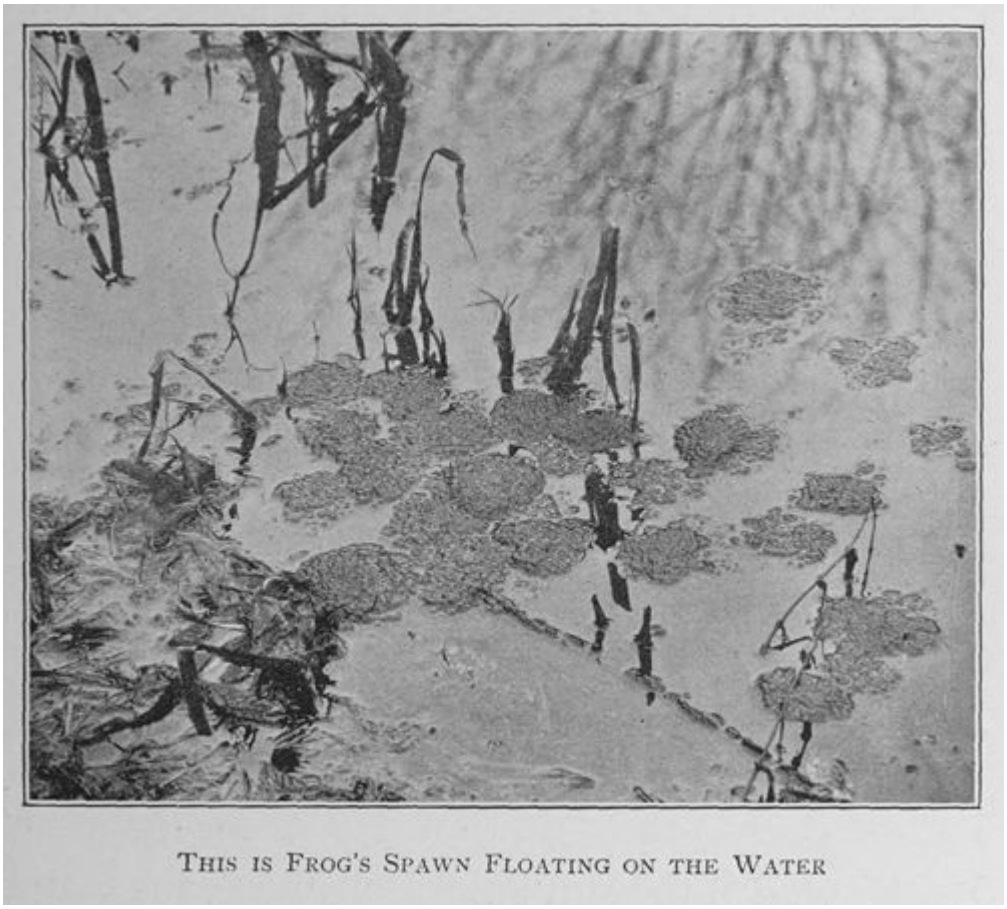
HOW many of you can tell me the difference between a frog-tadpole and a toad-tadpole? I don't mean when they are so small that it seems a kindness to call them tadpoles at all, but when they are quite a good size, with great fat heads and shiny little eyes and squiggly little tails. And how many of you can tell me the number of different kinds of tadpoles which one can find in England in the springtime? Most of you, I am sure, know a tadpole when you see one (sometimes he is called "pot-ladle,"or "polly-wog," or "horse-nail,") and some of you may know that a fat frog-tadpole is brown with little specks of gold, while a fat toad-tadpole is black all over; but I don't expect many of you know that there are two kinds of frog-tadpole, and two kinds of toad-tadpole, and three kinds of newt-tadpole, to be met with in England, which makes seven kinds of tadpoles in all.

Now as these seven little tadpoles are all different from one another (though the two frog-tadpoles and the two toad-tadpoles are not *very* different), we may be quite sure that they grow up into seven different little beasties. I am going to tell you something about

the frog- and toad-tadpoles now and leave the newt-tadpoles for another time, for it will be easier for you if you don't have too much to remember at once.

If you go into the country in springtime (the middle of March is the best time where I live, but in other places it may be a little earlier or a little later) and find a pond, or a brook which runs quite slowly, or even a hole in swampy ground which has water in it, you are almost sure to see a lump of stuff which looks like dirty grey jelly, either close to the bank or on the top of some of the weeds.

If you pick up a little of this, you will find (perhaps before it has slipped out of your fingers and perhaps after) that it is full of round black eggs.



THIS IS FROG'S SPAWN FLOATING ON THE WATER

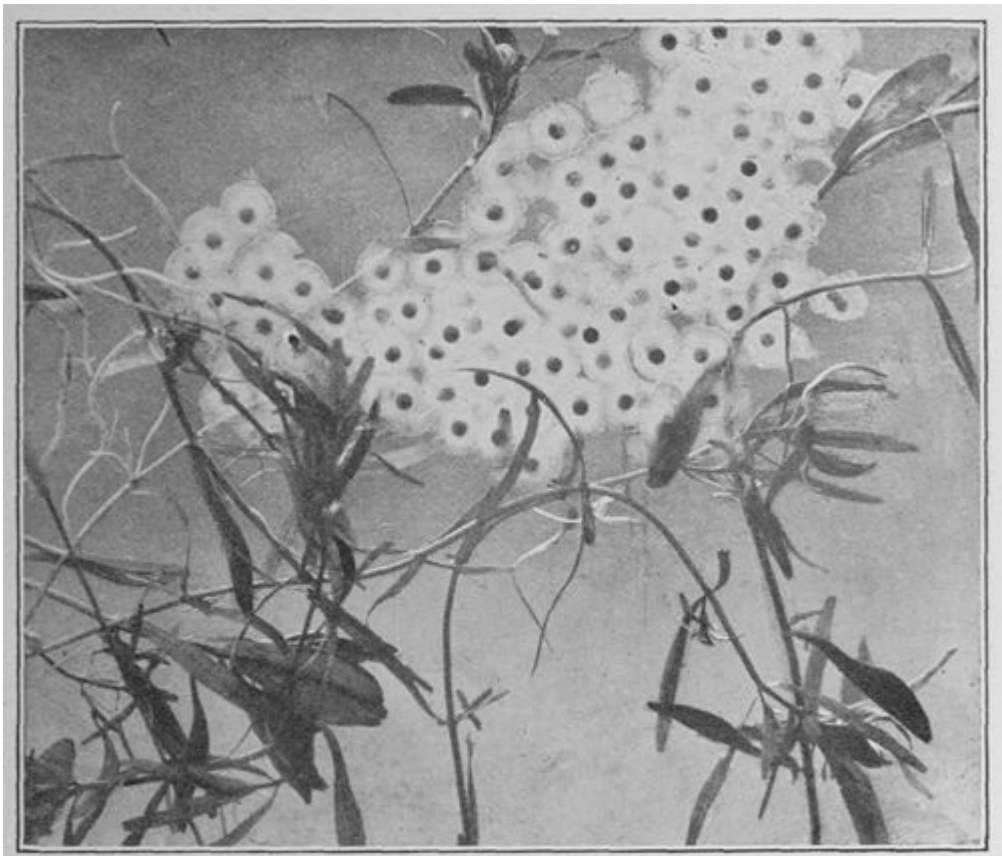
THIS IS FROG'S SPAWN FLOATING ON THE WATER

The grey jelly is either frog's spawn or toad's spawn.

If it is just a lump with no particular shape to it, it is frog's spawn, but if it is made up of small slimy ropes, which come apart from one another, and in which the eggs lie in rows like strings of black beads, it is toad's spawn. When you find toad's spawn, you may be sure that frog's spawn has been about for some time, for frog's spawn is always to be found rather earlier in the year. Whichever it may be you should take a little of it (quite a little is best) and put it in a glass jam-jar half full of water, and stand this in some bright, warm place, where it will not get knocked over, and where the sun will not shine directly on to it.

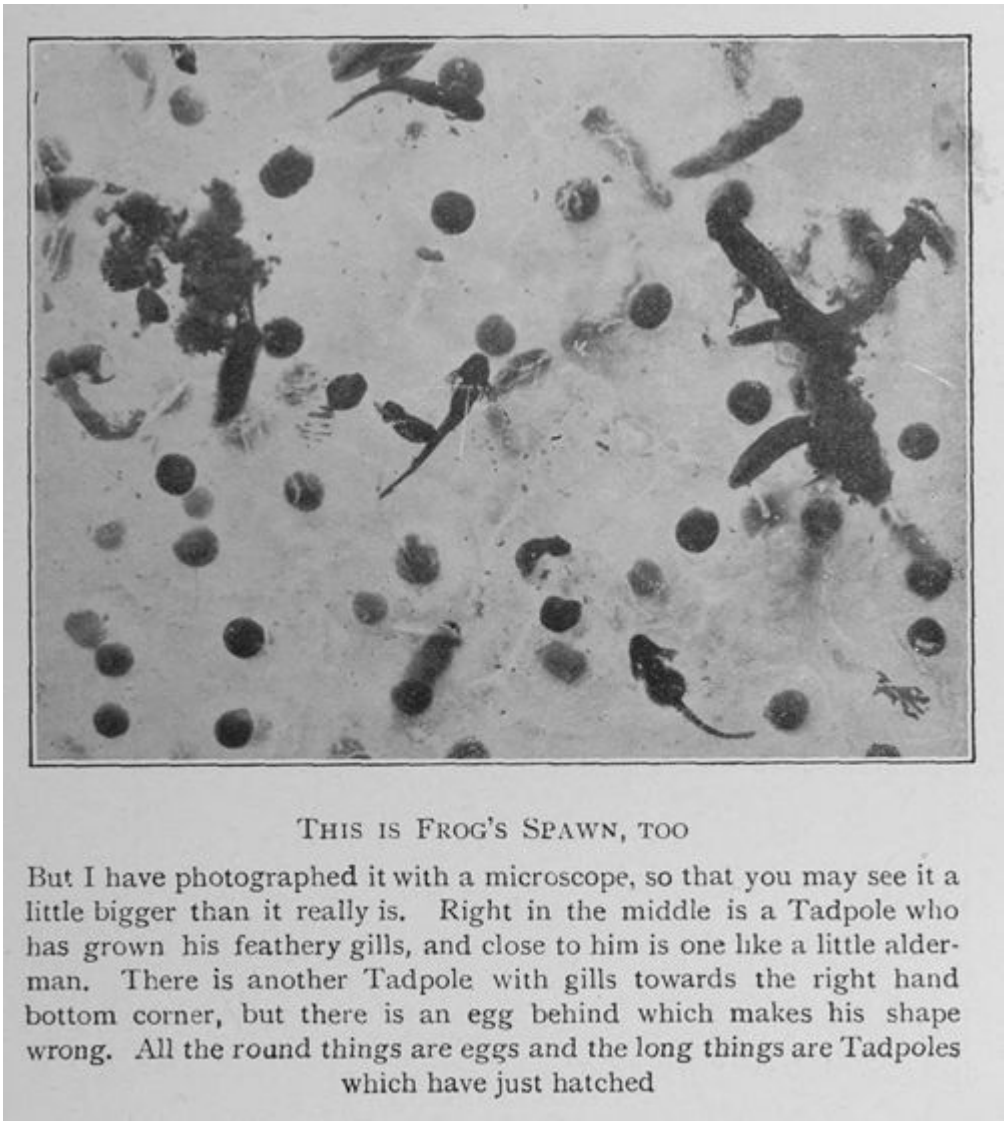
Frogs and toads usually lay their eggs in places where the sun *does* shine on them and warms them gently, and so hatches them out, but of course they do not lay them in glass bottles, and if the sun shines on these, the water will get warmer than is good for them, partly because there is no other water round to keep it cool, and partly because the bottle acts as a kind of burning-glass, and brings too much of the sunshine into itself, and so gives too much warmth to the eggs.

Some people think the jelly of frog's or toad's spawn acts like a burning-glass too; this, however, is a burning-glass which Mother Nature has arranged, and so there is no fear of its not acting properly.



THIS IS FROG'S SPAWN WHEN IT IS QUITE FRESH

If you find frog's or toad's spawn soon after it is laid, you will see only a small quantity of jelly round it, but this soon swells out and gets much bigger.



THIS IS FROG'S SPAWN, TOO

But I have photographed it with a microscope, so that you may see it a little bigger than it really is. Right in the middle is a Tadpole who has grown his feathery gills, and close to him is one like a little alderman. There is another Tadpole with gills towards the right hand bottom corner, but there is an egg behind which makes his shape wrong. All the round things are eggs and the long things are Tadpoles which have just hatched

THIS IS FROG'S SPAWN, TOO
But I have photographed it with a microscope, so that you may see it a little bigger than it really is. Right in the middle is a Tadpole who has grown his feathery gills, and close to him is one like a little alderman. There is another Tadpole with gills towards the right hand bottom corner, but there is an egg behind which makes his shape wrong. All the round things are eggs and the long things are Tadpoles which have just hatched

Have you ever seen Cook make a jelly? The first thing she does is to soak the gelatine in water, so that it gets soft and swells to twice the size it was before. It swells because it takes up water inside it, and frog's spawn does just the same. Now we must try and think what the frog's spawn jelly is for. It is really the white of the eggs,

FROG'S SPAWN
The Little Curly Tails are beginning to Grow

FROG'S SPAWN
The Little Curly Tails are beginning to Grow

world for all little frogs and toads. the black beads being the yolk. You wouldn't understand all its uses, but one is that it makes the frog's spawn much more difficult to eat, because it is so slippery. A great many water birds are very fond of frog's spawn and would gobble it up very quickly if they had a good, big spoon, instead of a rather small bill. As it is, a great deal of frog's spawn and a good many tadpoles are eaten up one way or another, which is really rather lucky for us, for frogs and toads lay millions and millions of eggs, and, if they all hatched out, there wouldn't be room in the

THE TADPOLES ARE HERE SEEN GETTING VERY LIKE FROGS
Most of them have all four legs, but one has only his hind legs at present

THE TADPOLES ARE HERE SEEN GETTING VERY LIKE FROGS
Most of them have all four legs, but one has only his hind legs at present

Well, if you keep your glass bottle with the eggs in it in a good place and look at it every day, you will find something fresh to interest you every day. First the black yolks will grow larger and change their shape so that they seem longer than they are broad, and presently you will find that they are turning into tadpoles. The baby tadpole seems much too fat to begin with, and sticks out in front like a little alderman; but soon he gets slimmer again, and you find that he is growing a curly tail (which no alderman ever did), and that there are tiny markings where his eyes and mouth are going to be. He is still very small (about a quarter of an inch long), but before he is much bigger a very wonderful thing happens—it has been happening all the time, though you have not been able to see it—he grows a pair of gills like a fish. They are delicate, feathery things, and stand out on either side of his head, I should like to say "neck," but I do not think I ought to because frogs and toads have no necks

at all, and so I suppose tadpoles have none either. All this time his tail is growing too, and presently it is long enough for him to swim with. When this happens he slips out of the jelly and wriggles about in the water. At present he has no real mouth, but he has a little opening, shaped like a horseshoe, near to where his mouth is going to be, and he uses this to hold on to weeds when he is tired, which he very soon is at first.

Once he is fairly hatched, however, his mouth grows quickly and he gets a pair of rather hard little jaws with which he can nibble the water-weed. When this happens you must, of course, put some water-weed into the bottle, though grass will do if you can't get anything else.

TADPOLES FULL GROWN
They are covered with little specks of gold. At the bottom one can be seen feeding

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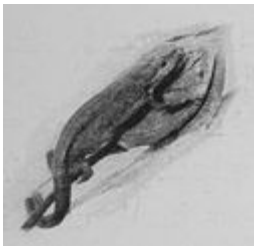
I told you that he had gills like a fish, but they are curious gills at this early stage because they have no flap of skin to protect them. If you want to see a fish's gills you must lift up the hard flap of skin which covers them. The tadpole soon grows a flap of skin, though, just like a fish, and this always appears first on the right side, so that at one stage he looks as if he had only one gill, the one on the left side. When both the flaps of skin have grown, the tadpole is really a little fish, and he stays in much the same shape, though he gets fatter and fatter, for about a month. At the end of this time he begins to grow legs, first the hind ones and then the front ones (newt-tadpoles grow the front ones first); but, in spite of his legs, he is still only a fish, because, instead of breathing the air with his lungs as a grown-up frog does, he breathes the water with his gills. During the next month, when he is getting on for three months old, another wonderful change comes over him. For a time he breathes both with his lungs (he has to put his head out of water for this) and with his gills, and so he is both a frog and a fish at once; but he gets more and more like a frog, and less and less like a fish. His lungs keep growing inside him, and his body and gills and tail get smaller and smaller, and his mouth and his eyes and his legs get larger and larger, and presently he leaves the water altogether, for he is tired of water-weeds and tired of his tail (he can swim beautifully without it), and he wants to make his meals off insects and slugs, and to learn how to croak and jump, and to be a great fat frog like Mother.

A FROG HE WOULD A-WOOING GO!

(VALENTINE'S DAY)



"THIS is better," gasped Bombinator.

Bombinatrix eyed him anxiously.

Only his waistcoat touched the ground. His eyes and nose had vanished. The right of either foot was now the left; the left of either hand was now the right; his head, subverted, curled to touch his toes, and, in his back, was a deep hollow.

This sounds involved, and that is just what Bombinator was.

"It's awful," said Bombinatrix.

"What do I look like?" spluttered Bombinator. "It's awkward talking to your feet."

"You're like—you're like a toadstool," said Bombinatrix, "a crinkled, gummy, yellow-spotted toadstool."

"That's the idea," said Bombinator, as he snapped back to shapeliness. "Now you try," and Bombinatrix tried.

"Passable," said Bombinator, "but not sufficient curl."

"It cricks my neck," she answered. Her head was slowly drooping.

"You *must* keep rigid," said Bombinator. "I can't see half the yellow. Throw back your head."

Bombinatrix threw back her head, until it grazed her toe-tips. Then she unstrung herself.

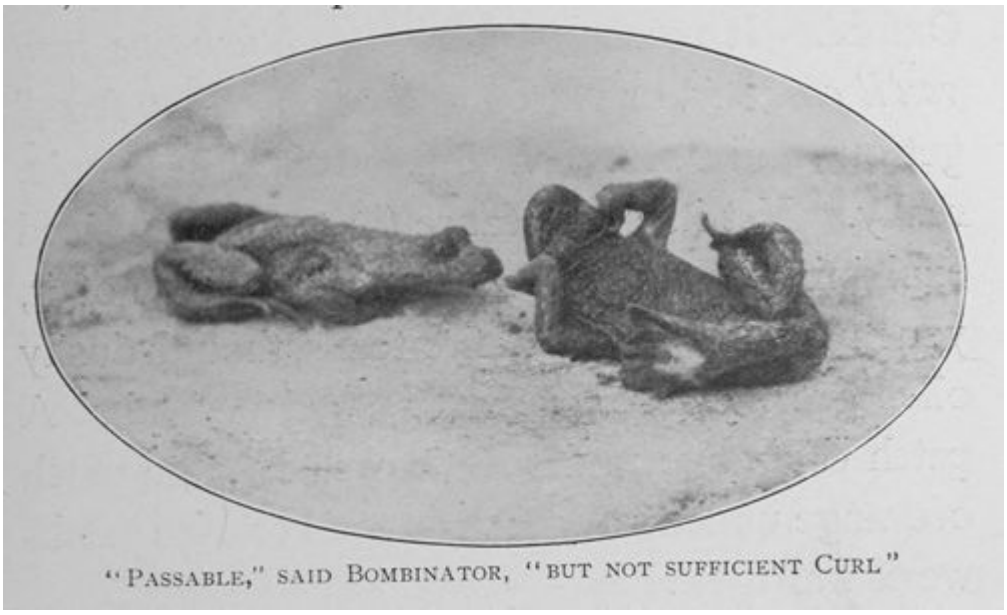
(I see you look incredulous. You ask and ask with reason: How came two fire-toads in an English garden? To this I answer frankly—I

put them there myself.)

Even a fire-toad loves his liberty, though prison-life may have its compensations. The breakfast gong, for instance, two taps upon the glass. The sluggish fatted meal-worm, the feeling of full-fed security.

Nor had there been a lack of company.

The Natterjack had livened things—by running races with his own reflection. So had the mottled Green Toad, an alien like themselves; so, in his own quiet way, the Salamander.



"Passable," said Bombinator, "but not sufficient Curl"

Each welcomed freedom differently.

The Natterjack went straight into the pond (quite the wrong thing for him), and swam with short-legged jerky sweeps up to the water-lilies. There he met the Water-Rat, of whom more later. The Green Toad sought the nearest tuft of grass, and, scratching with his fore-feet at the roots, contrived a roomy burrow. He backed inside and sat there quite content, blinking his emerald eyes. The Salamander stayed where he was put—and smiled.

The fire-toads climbed upon a stone and practised squiggles—aposematic squiggles.

That resonant epithet comes, I think, from Oxford. It means, *you dare to touch me and you'll catch it*, or words to that effect. "Apo," get out, and "sema," a sign. It is quite simple, really. Yet its significance (in toads) may need explaining, and, to be master of the sense of it, you must remember that fire-toads, though dusky olive green above, are orange red beneath. A patch of orange underneath each hand, a patch of orange underneath each foot, an orange patchwork waistcoat.

Now orange is a poison-label. It means in wild-folk speech, "Be careful," and yellow means the same; and when black joins the scheme, it means, "Be very careful, here is poison."

Sometimes the colour flaunts itself—witness the salamander, or the wasp. Sometimes it is concealed, witness the fire-toad. But fire-toads have the knack of showing it. Drop one upon his back and there he stays, knowing the underpart of him is fearsome. Startle one as he sits at ease, and he will flick into a knot, crinkly, immovable, unreal, with screaming labels at each corner. To be adept at this, the fire-toad needs spare living, one meal, at most two meals a day. When corpulent he finds the bend beyond him.

But corpulence is transient in toads. The first to find a waist was Bombinator, and Bombinatrix quickly followed. They now could travel with less apprehension. They made five equal hops and stopped. Before them stretched the pond, green-carpeted, a mirror-patch of water here and there, balsam and iris on the fringe of it, and fronting them, upon his leaf, the Rat.

The Natterjack had left him, and was swimming landwards. His head bobbed with each stroke, and he was slow in coming.

"The surliest brute I ever met," he said.

"The Rat?" said Bombinator.

"The Rat," replied the Natterjack. "He grumbled at my ripples in the water—and *he* makes noise enough. Just listen to him."

The Water-Rat had left his leaf, and now was in the reed-stems. He held a two-inch cutting in his paws. They heard his munching plainly.

"This is a queer pond," said the Natterjack; "it's full of noises. A shrew-mouse chirped as I swam back, and half a dozen bubbles struck me. That means there's something grunting. My yellow stripe! what's that?"

It rose *crescendo*,

"*brek-ek-ek-ek-ek-ek-ek-ek-EX!*"

and finished *amoroso*,

"*KO-ax! KO-ax! KO-ax!*"

"I know it," shrieked Bombinator. His little eyes were starting from their sockets, as he sat up entranced.

"I know it," echoed Bombinatrix.

"Then you might share your knowledge," snapped the Natterjack. Jealousy had convulsed him, for he too can sing.

"A French Frog," cried Bombinator.

"A French Frog," echoed Bombinatrix, and in a rattle came the southern notes:

"*brek-ek-ek-ek-ek-ek-ek-ek-EX!*"

"*KO-ax! KO-ax! KO-ax!*"

"I'll find him, if I hop all night," said Bombinator.

He plunged aside into the grass, and Bombinatrix followed at his heels.

The Natterjack soon caught them. He ran with little mouse-steps.

"Are you quite prudent?" he jerked out.

"Prudent?" said Bombinator, "why, he's a countryman."

So all three went together, and dropped abreast into the Green Toad's burrow.

"Have you heard him?" said Bombinator.

The Green Toad was half dozing.

"Heard what?" he muttered sleepily.

"The French Frog," said Bombinator. "Come out and listen."

They pulled him out between them.

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The Green Toad slowly stretched himself.

"*That?*" said he, "that's not French." Then he relapsed to sleep again.

"What did I tell you?" said the Natterjack.

"You told us nothing," said Bombinator. "Let's ask the Salamander."

The Salamander had not moved an inch.

"Is that song French?" the Natterjack inquired.

The Salamander slowly raised his head, curled S-wise out and home again, blinked either eye three times, smiled fatuously at each toad in turn, and then smiled at the sky.

"Oh, come on!" said the Natterjack. The Natterjack is all on wires, and Salamanders madden him.

"*brek-ek-ek-ek-ek-ek-ek-ek-EX!*"

"*KO-ax! KO-ax! KO-ax!*"

The Natterjack now led them, faster and faster as the song grew louder, hippy-hoppy, hurry-scurry, bumping against the snails and spiders, starting the flies and beetles, and rousing every sleeper in the grass.

Small wonder that they soon encountered trouble.

They wakened the King Toad.

Since you last knew him, the King Toad has grown. His waist is fourteen inches. His mouth could welcome three small toads abreast.

The fire-toads crouched in front of him (the mouth seemed very wide); even the Natterjack hung back, and waited to be spoken to.

Ten minutes passed, and then the King Toad spoke, in slow, imperial-measured tones.

"Who are you?" said he, and fixed his royal eye on Bombinator.

Bombinator's mouth was flattened to the ground, and his reply was indistinct.

"Speak louder," said the King Toad.

But Bombinator kept his head. If he spoke louder he must move, and, if he moved, he might be swallowed.

Once more he muttered with closed lips.

The King Toad slowly raised one foot. Before it reached the ground again the Natterjack had vanished. So had the fire-toads, but in different fashion. Where they had been were now two spotted toadstools.

"That's a queer trick," said the King meditatively. "Orange underneath I see. Risky to eat without inquiries. Come back, Natterjack."

THE SALAMANDER HAD NOT MOVED AN INCH

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Two yellow eyes were peeping round a dock-leaf. The Natterjack slouched low in the Presence.

"Have you seen this trick before?" said the King Toad coldly.

"I have, Sire," said the Natterjack.

"Do it yourself," said the King Toad.

"Alas, Sire," said the Natterjack, "I am too stout."

"Not a bad fault," said the King more graciously, "not a bad fault. What is the meaning of it?"

"It means, Sire, that my two small friends are frightened."

"Frightened?" said the King Toad; "frightened of what?"

"Of you, Sire."

THE NATTERJACK SLOUCHED LOW INTO THE PRESENCE

THE NATTERJACK SLOUCHED LOW INTO THE PRESENCE

"Of me?" said the King Toad. "Why should a toad fear me? I am the Protector of all toads." He swelled himself imperially.

"Have You Seen this Trick before?" said the King Toad

"These are strange toads, Sire," said the Natterjack, "they come from France."

"France?" said the King; "this must be looked to. The place is being overrun with aliens. Undo them, Natterjack."

The Natterjack looked pained.

"Sire," he gasped out, "they're poisonous. I bit one once, and could not sing for days."

"Could not sing for days?" said the King. "Could not sing for days?" The shadow of a smile played round his mouth.

"Just fetch me that French Frog," he said.

"Sire," said the Natterjack, "it was during our unsuccessful search for him that we had the felicity of being so graciously received by your Majesty."

"You know him then," said the King, frowning.

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